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9 July 2004

Dear Sirs

International patent application No PCT/DK2003/00497
Applicant: Danmarks Tekniske Universitet
International classification: IPC C23C8/22
Time limit: 18 July 2004
My ref: 77674 HD/ge

In reply to the Written Opinion of 18 May 2004 I hereby file amended claims and a description adapted hereto to form the basis of further prosecution of this case.

On behalf of the Applicant, I shall make the following comments.

Claim amendments

The new claim 1 is a combination of the originally filed claim 1 and claim 2 including deletion of "Fe". The feature "the case-hardening is carried out at a temperature at which carbides and/or nitrides are produced" is added to claim 1. The basis for this restriction can be found in the originally filed claims 3 and 4.

The new claims 2-9 correspond to the originally filed claims 3-10.

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The original claim 11 has been deleted in order to meet the Examiner's objection under paragraph 4.

Hence, all amendments are based on the application as filed in accordance with PCT Article 34 (b).

"Stainless steel" is defined as steel comprising at least 10 % chromium by weight. Claim 1 is restricted to case-hardening of a stainless steel article.

Novelty

D1 (NL 1003455) discloses a method in which an article of iron or low alloyed steel is plated with a layer of e.g. nickel before gas nitrating or gas carburization. As D1 does not relate to case-hardening of "stainless steel", claim 1 is novel over D1.

D2 (US 4,013,487) relates to a method of producing a corrosion-resistant carburized steel article in which a layer of nickel and/or cobalt is applied to the surface of a steel article, after which the coated steel article is carburized at an austenitic temperature ranging from about 800-1,000°C (see claim 1 of D2). The object of the method according to D2 is to improve the corrosion resistance of carbon steel. As D2 does not relate to case-hardening of an article made of stainless steel, claim 1 is novel over D2.

D3 (JP 59006367) relates to a method of providing a corrosion-resistant layer by which a base-material with a chromium content of only 1.12 % which is not of stainless steel is nickel-plated and carburized or carbonitrided. As D3 does not relate to case-hardening of a stainless steel article, claim 1 is novel over D3.

D4 (EP 0248431 B1) relates to gas nitriding of a stainless steel article which is coated with a layer of iron. Claim 1 is restricted to a top layer of Ni, Ru, Co or Pd and is therefore novel over D4.

D5 (DD 294048A5), D6 (WO 01/55470 A2) and D7 (WO 00/50661 A1) all disclose methods of case-hardening of stainless steel articles provided with a top layer of iron. As claim 1 is restricted to a top layer of Ni, Ru, Co or Pd, claim 1 is novel over D5, D6 and D7.

Inventive step

As D4, D5, D6 and D7 all relate to case-hardening of stainless steel articles, one of these documents should be chosen as the closest prior art. As D6 deals with the problem of formation of carbides, which deteriorates the corrosion properties of the stainless steel, D6 is chosen as the closest prior art.

There are several drawbacks of plating a stainless steel article with iron before case-hardening. An electroplated iron layer has poor corrosion properties. If the article is not case-hardened immediately after it is electroplated, the iron will corrode, i.e. a porous iron oxide layer will be formed. Thus, a thin iron layer will corrode through to the stainless steel in few days whereby atmospheric air can reach the surface of the stainless steel and thereby repassivate this. By applying a layer of nickel, ruthenium, palladium or cobalt, a relative corrosion-resistant surface, which is permeable for nitrogen or carbon atoms, will be obtained. Tests have shown that an article of stainless steel which has been covered with a thin nickel layer has the same properties of case-hardening after three months of storage as immediately after the article was covered with nickel.

Another drawback of using a top layer of iron is that iron atoms during the case-hardening at elevated temperatures will diffuse into and contaminate the outermost of the stainless steel. These iron atoms will not be removed by the following removal of the iron layer by e.g. etching whereby the corrosion-properties are deteriorated. Nickel, ruthenium, palladium or cobalt will not affect the corrosion-properties of stainless steel, although atoms diffuse into the outermost layer of the stainless steel. It is actually a well-known fact that a combination of nickel and chromium has a positive effect on the corrosion properties.

D1 discloses a method where a layer of cobalt, copper, palladium or nickel is applied to an article of iron or low alloyed steel before nitriding. By this method, a nitride layer is formed. The object of the nickel layer according to D1 is to obtain a pore-free nitride layer. Thus, D1 relates

to case-hardening of another material, namely iron or low alloyed steel, and has the completely different object of avoiding pores and at the same time obtaining formation of iron nitrides. By the present invention, the formation of iron or chromium nitrides is to be avoided as it weakens the corrosion properties of the stainless steel. Thus, a skilled person faced with the problem of the method according to D6 would not find the solution in D1. Consequently, claim 1 has inventive step when starting from D6 and combining with D1.

D2 relates to case-hardening of a low alloyed steel article which is provided with a first metallic layer of nickel and/or cobalt and a second metal coating of a metal selected from the group consisting of Cr, Sn, Pv, Zn, Cu and Cd (see claim 1 of D2). Thus, D2 provides a method for improving the corrosion properties and other properties of a low alloyed steel article. Furthermore, the carburizing is carried out at a temperature between 800 and 1,000° C (see claim 1 of D2). Carburizing stainless steel at these temperatures would cause formation of chromium carbides. A skilled person faced with the problem of D6 would not find the solution in D2. Thus, claim 1 is inventive when starting from D6 and combining with D2.

Also, D3 relates to a method of improving the corrosion properties of a low alloyed steel article (with only 1.12 % chromium) by applying a nickel layer before carburization or carbonitriding. D3 does not deal with the object of improving the hardness of stainless steel without deteriorating the corrosion-properties. A skilled person faced with the problem of D6 would not find the solution in D3. Thus, claim 1 has inventive step when starting from D6 and combining with D3.

The Examiner is respectfully requested to acknowledge the novelty and the inventive step of this application on the present basis.

Yours faithfully
CHAS. HUDE A/S

Henrik Dylmer
Representative of the applicant

Encs: Amended pages 1, 3, 4 and 12
New claims 1-10
Draft showing amendments
Form 1038